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PB-293 160

Energy-Related Air Quality Monitoring in the Western Energy Resource Development Area

(U.S.) Environmental Monitoring and Support Lab, Las Vegas, NV

Nov 78

United States
Environmental Protection
Agency

Environmental Monitoring
and Support Laboratory
P.O. Box 15027
Las Vegas NV 89114

EPA-600/7-78-227
November 1978

PB 293160

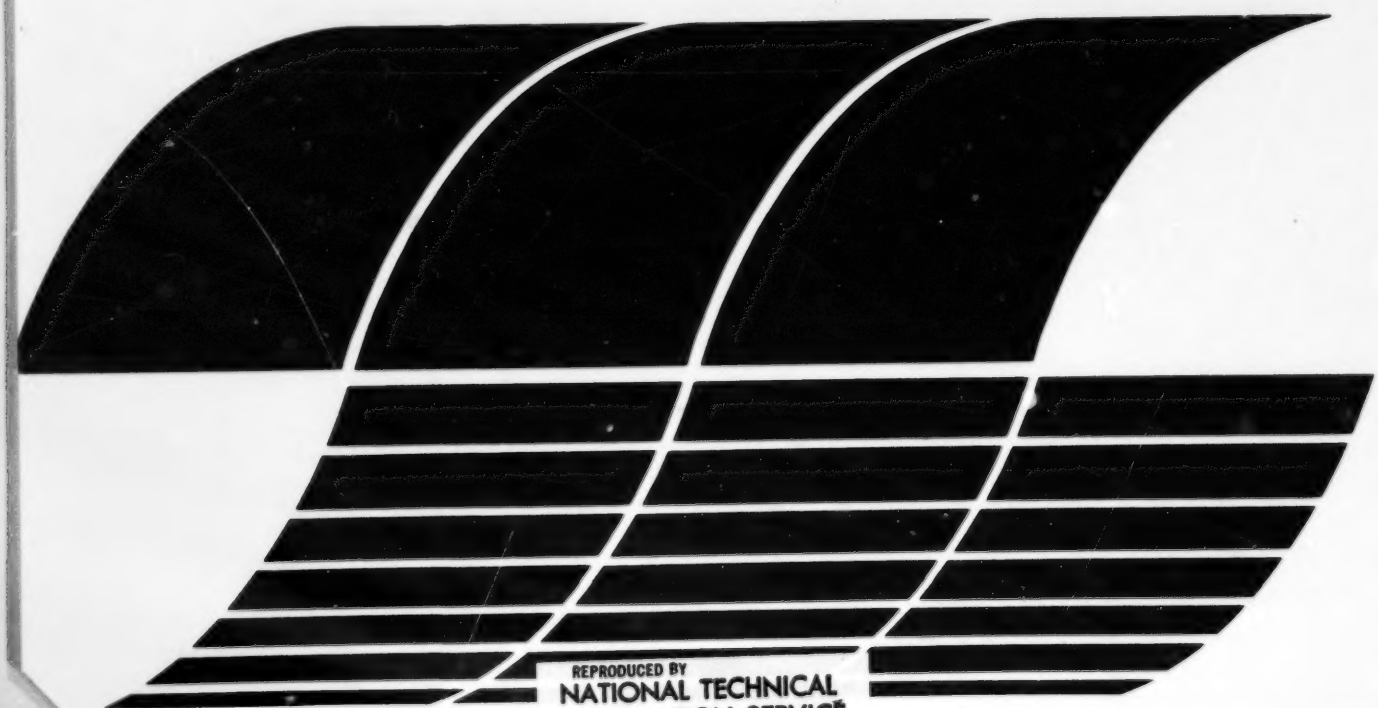
Research and Development

EPA

Energy-Related Air Quality Monitoring in the Western Energy Resource Development Area

Interagency Energy-Environment Research and Development Program Report

MAR 28 1979



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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/7-78-227		PB293160

4. TITLE AND SUBTITLE	5. REPORT DATE
ENERGY-RELATED AIR QUALITY MONITORING IN THE WESTERN ENERGY RESOURCE DEVELOPMENT AREA	November 1978
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) M. Pitchford, R. Snelling, J. Bowen, M. Pearson and D. McNelis	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Monitoring and Support Laboratory Office of Research and Development U.S. Environmental Protection Agency Las Vegas, Nevada	10. PROGRAM ELEMENT NO. INE625C
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency-Las Vegas, NV Office of Research and Development Environmental Monitoring and Support Laboratory Las Vegas, Nevada 89114	13. TYPE OF REPORT AND PERIOD COVERED
	14. SPONSORING AGENCY CODE EPA/600/07

15. SUPPLEMENTARY NOTES

16. ABSTRACT

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
meteorology air pollution quality assurance instrumentation visibility fossil fuel coal	WERDA energy-related effects air monitoring	04B 13B 14D

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
RELEASE TO THE PUBLIC	UNCLASSIFIED	62
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE PC A04/MF A01

EPA Form 2220-1 (9-73)

☆ U.S. GPO:1979-684-165/2039

EPA-600/7-78-227
November 1978

ENERGY-RELATED AIR QUALITY MONITORING IN THE WESTERN ENERGY RESOURCE DEVELOPMENT AREA

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FOREWORD

Protection of the environment requires effective regulatory actions which are based on sound technical and scientific information. This information must include the quantitative description and linking of pollutant sources, transport mechanisms, interactions, and resulting effects on man and his environment. Because of the complexities involved, assessment of specific pollutants in the environment requires a total systems approach which transcends the media of air, water, and land. The Environmental Monitoring and Support Laboratory-Las Vegas contributes to the formation and enhancement of a sound monitoring data base for exposure assessment through programs designed to:

- develop and optimize systems and strategies for monitoring pollutants and their impact on the environment
- demonstrate new monitoring systems and technologies by applying them to fulfill special monitoring needs of the Agency's operating programs

This report describes a program designed to establish an environmental data base which will be used to assess the air quality impact of existing and proposed energy developments throughout the Western Energy Resource Development Area. The purpose of this report is to provide information concerning this program to those persons who are actively involved in the study of the environmental impacts of energy utilization. Additional information on this and related programs can be obtained by contacting the Air Quality Branch of the Laboratory.

George B. Morgan
Director
Environmental Monitoring and Support Laboratory
Las Vegas

ABSTRACT

This report describes a program designed to create an environmental data base which will be used to assess the air quality impact of energy development in an eight-state region (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, Wyoming). The program was designed to use and augment existing monitoring activities as well as create new monitoring systems. Some of the activities described are an airborne air quality monitoring system, a regional particulate sampling network, a quality assurance program, a visibility monitoring system, an air quality simulation modeling program, and a program to investigate weather modification effects of energy-related pollutants. This report covers a period from January 1975, to April 1977, and work was completed as of August 1977.

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INTRODUCTION

The U.S. Environmental Protection Agency's Environmental Monitoring and Support Laboratory-Las Vegas (EMSL-LV) is engaged in a comprehensive program to evaluate the real and potential air quality impacts of energy-related developments in the Western Energy Resource Development Area (WERDA) (Figure 1). (EMSL-LV is also conducting other energy related programs.) Of particular interest are proposed developments in the eight-state region encompassing the Northern Great Plains, the oil shale regions of Colorado and Utah, and the Four Corners area. Monitoring is oriented chiefly to nitrogen dioxide, nitrogen oxide, sulfur dioxide, ozone, reactive hydrocarbons, fine particulates, trace elements, and visibility.

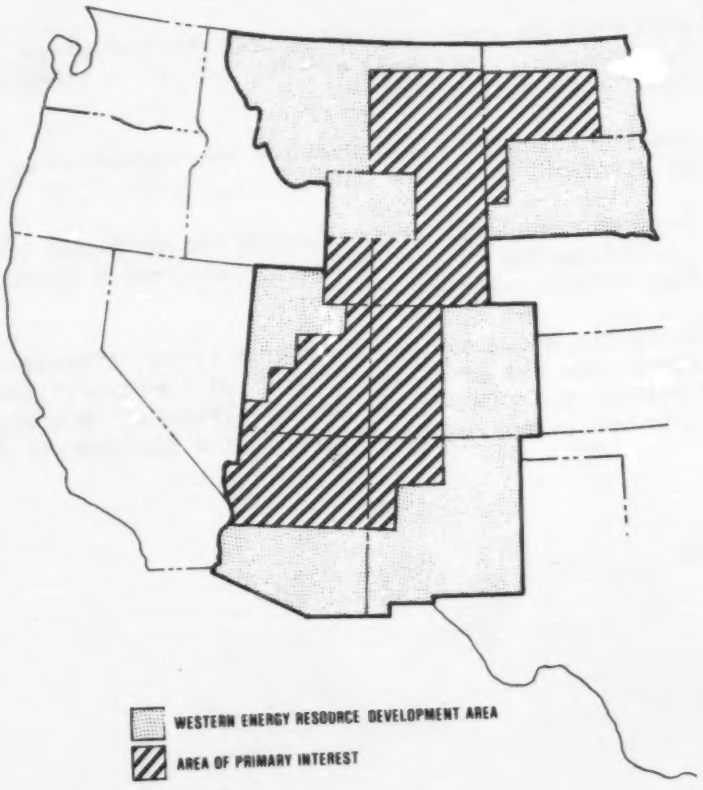

Figure 1. The Western Energy Resource Development Area

The primary objectives of the program are to establish an energy-related air quality baseline, evaluate air quality trends, assess the impacts of specific energy-related development activities, and predict the impacts of proposed energy developments. Six major program tasks have been identified to meet these objectives:

1. Prepare and maintain a source and monitoring network inventory and establish an energy-related air quality data base. This includes the evaluation and augmentation of present networks in terms of sampling location, frequency of sampling, procedures, and analyses being performed.

2. Establish an analytical quality assurance program to determine the accuracy and precision of data obtained from networks being run by different organizations and programs.

3. Establish a monitoring network in the Four Corners region and augment stations in other study states to monitor for total suspended particulates, particulate nitrate and sulfate, and trace elements.

4. Perform wide-area monitoring over regions of potential energy development. This will require use of an airborne air quality monitoring system.

5. Develop and deploy a system for the quantitative measurement of atmospheric visibility.

6. Develop a regional scale atmospheric diffusion model for predicting the impact of energy development scenarios on the Four Corners region.

In addition to the above six major program tasks, a research program designed to investigate the potential effects of energy-related air pollutants on weather and climate has been initiated. This work is being performed for the EPA by the National Oceanic and Atmospheric Administration.

BASELINE MONITORING

In initiating any comprehensive impact analysis program, it is essential that a source and monitoring network inventory be prepared and maintained. To determine the adequacy of existing monitoring efforts, the nature and extent of those efforts must be known and compared with anticipated monitoring requirements. The existing and projected source characteristics and configurations provide the bases for estimating the monitoring requirements. An analysis of this nature identifies monitoring deficiencies which must then be eliminated if possible or diminished through remedial monitoring network augmentation.

Existing and proposed electric power generating facilities, proposed oil shale development sites, and proposed coal conversion facilities have been identified along with their schedule for implementation. Coal-fired power plant development represents the most immediate and extensive potential impact on air quality. A 10-year scenario outlining the development programs of present and proposed electric generating facilities as of January 1, 1977, is shown in Appendix A.

An inventory of state and federal air quality monitoring stations within the eight states comprising the Western Energy Resource Development Area is shown in Appendix B. Both energy-related and non-energy related stations are listed. The stations are further classified as representing background, population, or source-related sites. A summary of energy-related air quality monitoring sites is shown by state and classification in Table 1. Table 2 summarizes these same stations according to analyses performed. Table 3 further classifies the stations as to the city center, suburban, rural or remote locations. A program will be designed to verify and refine these station classifications.

Air quality and meteorological monitoring is also being performed by private industry. These activities are not reflected in the tables. This is due primarily to the problems associated with obtaining data from and applying a quality assurance program to private monitoring activities. The most extensive industrial monitoring is being done at the Federal Oil Shale Lease Sites in Utah and Colorado. A summary of these activities is presented in Appendix C.

Most of the existing air monitoring programs were not specifically designed to characterize energy development impacts. Power plant emissions represent the greatest energy-related impact to air quality. The air quality parameters which best characterize these emissions are particulate sulfates and fine particulates. The greatest impact of increased levels of these pollutants in the west will likely be a degradation of visibility. Sulfates are monitored at a few locations (Figure 2) but neither fine particulates nor

TABLE 1. SUMMARY OF WERDA AIR QUALITY MONITORING SITES
(Based on SAROAD listing, December 1975)

STATE	Surveillance Classification (Stations-Locations)			
	Population	Source	Background	Totals
Arizona	6-6	6-6	13-13	25-25
Colorado	19-19	-	7-5	26-24
Montana	11-2	2-2	12-11	25-15
New Mexico	7-4	11-7	4-4	22-15
North Dakota	9-8	-	11-9	20-17
South Dakota	3-1	3-3	8-7	14-11
Utah	2-2	2-1	14-10	18-13
Wyoming	18-14	5-2	11-6	34-22
Total	75-56	29-21	80-65	184-142

TABLE 2. ANALYSES PERFORMED, WERDA AIR QUALITY MONITORING SITES

	Analysis Performed*							
By States	TSP	TE	SO_4	SO_2	NO_2	O_3	CO	HC
Arizona	24	23	11	4	3	-	-	-
Colorado	26	19	-	-	-	-	-	-
Montana	21	-	-	8	7	2	2	2
New Mexico	18	4	-	8	2	-	2	-
North Dakota	20	11	11	6	6	-	-	-
South Dakota	14	1	1	5	3	-	-	-
Utah	18	9	-	7	3	-	-	-
Wyoming	34	3	3	15	8	-	-	-
Total	175	70	26	53	32	2	4	2
By Classification								
Population	72	33	17	17	10	1	3	1
Source	24	4	2	13	2	-	-	-
Background	79	33	7	23	20	1	1	1
Total	175	70	26	53	32	2	4	2

* TSP - total suspended particulate
TE - trace elements
SO_4 - sulfate
SO_2 - sulfur dioxide
NO_2 - nitrogen dioxide
O_3 - ozone
CO - carbon monoxide
HC -hydrocarbon

TABLE 3. CLASSIFICATION OF WERDA AIR QUALITY MONITORING SITES

		Surveillance Classification		
		Population	Source	Background
City Center	Industrial	1	0	0
	Residential	9	2	0
	Commercial	24	0	0
	Mobile	2	0	0
	Total	36	2	0
Suburban	Industrial	0	5	0
	Residential	8	1	3
	Commercial	3	0	0
	Mobile	0	1	0
	Total	11	7	3
Rural	Near Urban	3	0	0
	Agricultural	3	5	19
	Commercial	3	0	1
	Industrial	0	3	1
	Unqualified	3	2	2
	Total	12	10	23
Remote		1	4	45
Unspecified		15	6	9
Total		75	29	80

visibility degradation is monitoried on a regular basis at any location. A further deficiency becomes apparent when the locations of monitoring sites are plotted on a map of the Western Energy Resource Development Area. The density of sites is low in the Four Corners region and other areas in the vicinity of anticipated large-scale energy activities.

The actions being taken to remedy many of these problems are discussed in other sections of this report. Briefly, these are the initiation of an airborne air quality monitoring program, the operation of a Four Corners particulate characterization monitoring network, the development of a visibility monitoring capability and the use of regional scale air quality simulation modeling.

Two recently initiated programs are the development of an expanded sulfate network and the development of a fine particulate monitoring capability. The States of Montana, North Dakota, South Dakota and Colorado are now performing sulfate analysis on particulate samples collected at 32 selected stations. This is being funded in part by the EMSL-LV through EPA Region VIII grant programs to these states. The Ute Research Laboratory, under contract to the EMSL-LV, is performing sulfate and nitrate analysis on the Four Corners Network (28 stations) and will expand the program to include samples from sites in the States of Utah and Wyoming (16 stations). These additional 76 sites (Figure 3) along with those already performing this analysis constitutes the Western Energy Sulfate Nitrate Monitoring Network.

The EMSL-LV is engaged in a program of field testing several size-segregating particulate samplers to determine which instrument or combination of instruments can be most effectively used in the Western Energy Resource Development Area. The ultimate goal of this program is the establishment of a fine-particulate sampling network. Two types of sampler are being field tested. One is a three-stage device which collects daily samples automatically over a 1-week period. A modest network of these samplers is now being deployed in the Four Corners region (six instruments).

The other sampler being field tested is a less sophisticated device which is simply attached to a high volume (HiVol) sampler, making it possible to collect particulates in two size ranges. The results from field tests of this sampler, the size-segregating sampler and other instruments will provide information necessary to the planning of a fine particulate monitoring network.

FOUR CORNERS MONITORING NETWORK

The Ute Research Laboratory (URL) at Fort Duchesne, Utah, is under contract to EMSL-LV to operate and analyze samples collected from an extensive network of HiVol samplers covering the Four Corners area of Utah, Colorado, Arizona and New Mexico. The 28-station network has been operational since January 1976 and represents the most comprehensive background particulate monitoring program in the Four Corners area (Figure 4).

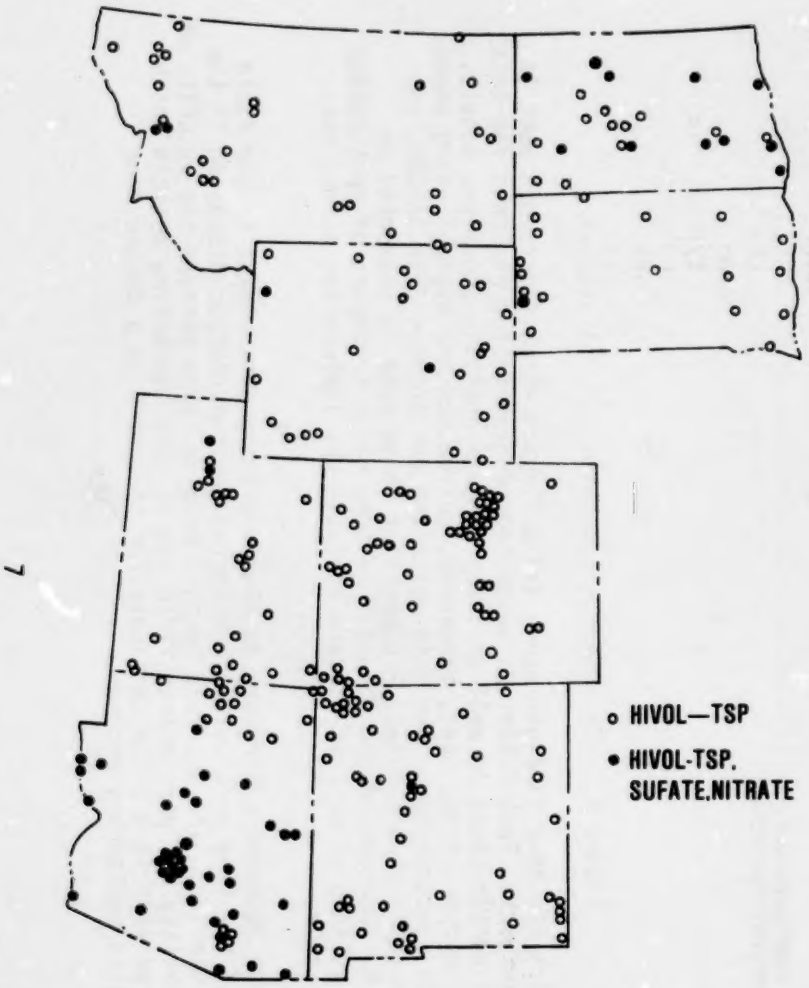

Figure 2. Particulate sampling in the WERDA (1976)

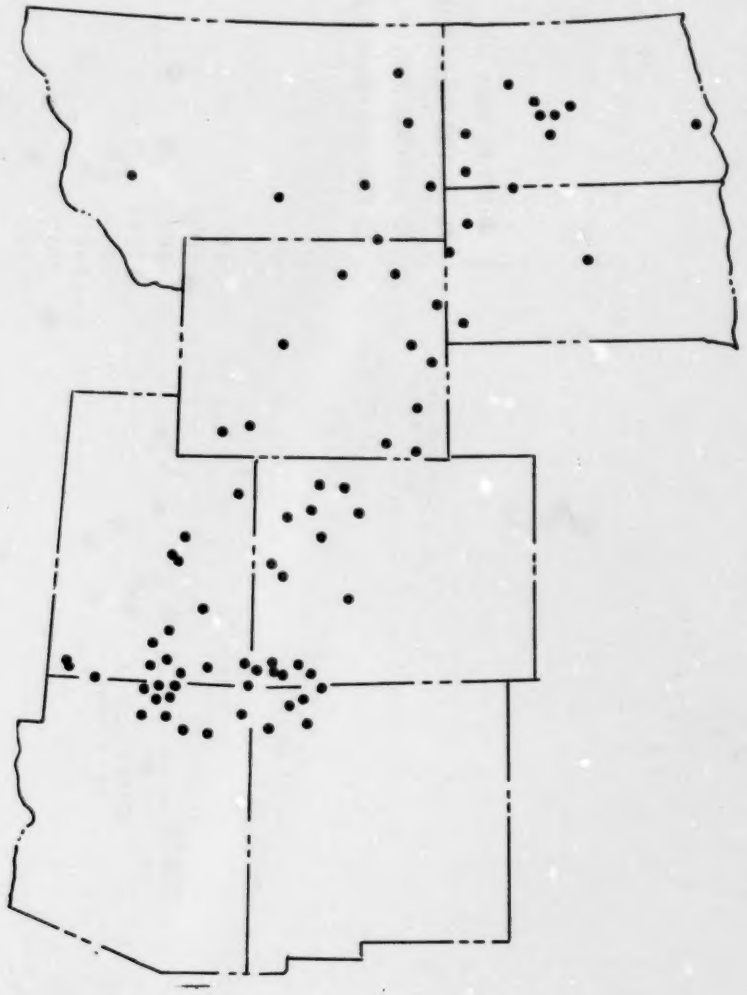

Figure 3. New sulfate-nitrate monitoring sites (Added during 1977)

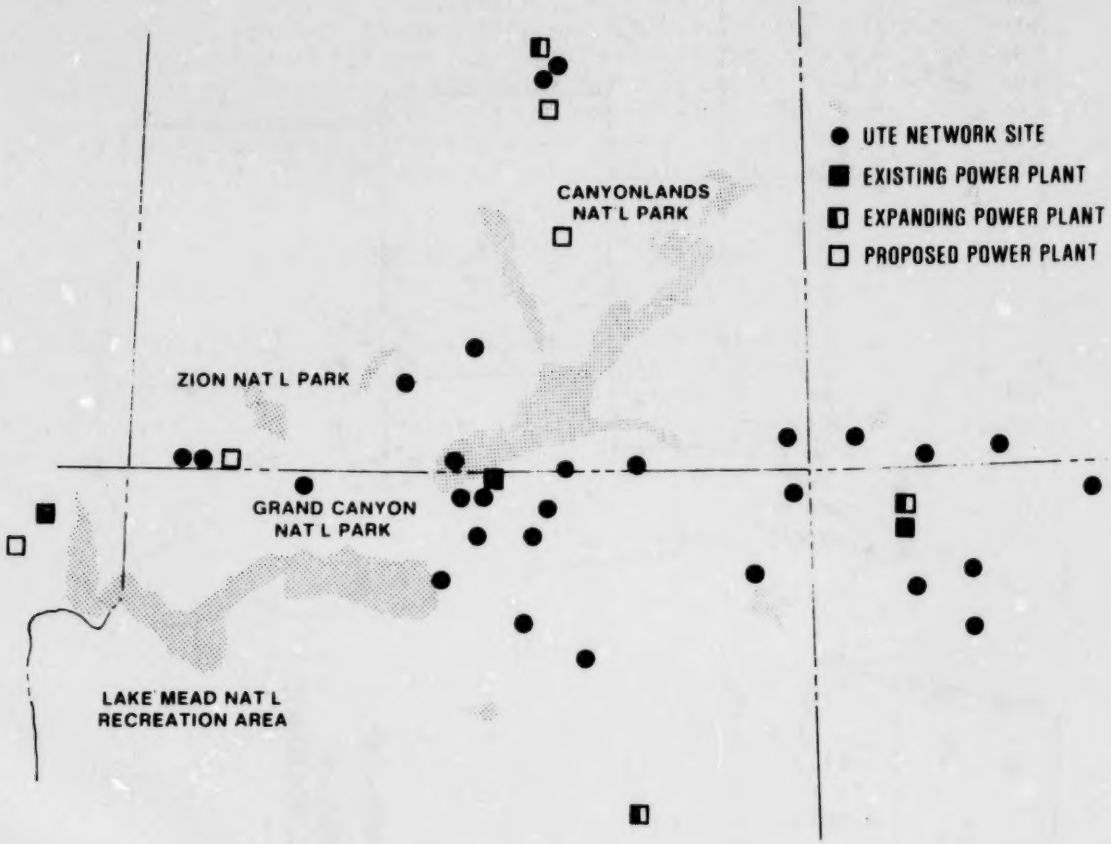

Figure 4. UTE Research Laboratory Hi-Vol network

Filters (24-hour time-averaged) are collected three times each week in the URL network. Each filter is subjected to gravimetric analysis for total suspended particulates as well as trace element analysis (cadmium, cobalt, chromium, copper, iron, lead, manganese, molybdenum and nickel) using atomic absorption spectroscopy. The data collected are entered into SAROAD, the EPA's air quality data base. A summary of these data is presented in Appendix B. Because of the interest in long range transport of particulate sulfate, sulfate as well as nitrate analysis was implemented during the summer of 1977.

The Ute Research Laboratory is also a primary participant in the field testing of the fine particulate monitoring instrumentation discussed in the previous section. The URL role in that program is to perform the majority of the feasibility and performance field tests. The monitoring network which the URL operates is a prime candidate for inclusion in a future fine particulates monitoring program.

To aid in the interpretation of the trace element analysis data, a soil sampling and analysis program for the Four Corners Monitoring Network is underway. The identification of an elemental constituent signature for wind-suspended soil is the goal for this project. A tool of this type can be used to assess the contribution from local sources of windblown dust to which the periodic high values of total suspended particulates in the southwest are commonly attributed. This project is the initial step in a more comprehensive program to develop trace element signatures for all of the major particulate sources influencing the Four Corners region.

ANALYTICAL QUALITY ASSURANCE PROGRAM

A number of agencies at the federal, state, and local level as well as private industry are collecting the aerometric data which are becoming the data base from which an impact analysis will be performed. To assure accuracy and data comparability between these programs, an analytical quality assurance program has been initiated. Rockwell International, under contract to the EPA, is performing this function (This contract is managed through the Quality Assurance Branch, Environmental Monitoring and Support Laboratory-Research Triangle Park).

The analytical quality assurance program consists of four tasks:

Task 1. Laboratory and sampling site system review.
Under this task the contractor performs on-site system reviews of all laboratories and selected sampling sites involved in the energy program. Reports are prepared indicating the positive aspects of the laboratory, deficiencies found, recommendations for corrective action, and judgement as to the ability to support the energy project. All laboratory visits were completed by December 1976.

Task 2. Quarterly performance audit.
Concurrently with Task 1, the contractor initiated a program of quarterly performance surveys of all participating laboratories using the following test materials: nitrogen dioxide (5 concentrations), sulfur dioxide (5 concentrations), carbon monoxide in air (5 concentrations), non-methane hydrocarbon in air, and a HiVol flow measurement device. The following devices will also be included when they become available: a nitrogen oxide-nitrogen dioxide-nitric oxide dynamic calibration device, an ozone calibration device and a sulfur dioxide dynamic calibration device. In addition, 10 percent of the Ute Research Laboratory's samples are being reanalyzed for trace elements. Reports on the performance audit program are being prepared on a quarterly basis.

Task 3. Dynamic calibration.
Quarterly on-site dynamic calibration audits are being performed for all energy-related continuous monitoring stations.

Task 4. Technical assistance.
The contractor is providing technical assistance to participating laboratories. This also helps the Quality Assurance Program to promote improvements in data quality.

A list of laboratories and field stations participating in the Quality Assurance Program is shown in Tables 4 and 5.

WIDE-AREA MONITORING

Understanding the relationships between energy development and air quality in the Western Energy Resource Development Area requires a knowledge of the production, transport and dispersion of air pollutants. Standard ground-level air quality monitoring provides only point measurements at the earth-atmosphere interface. Information gathered at this interface is of vital importance because of the direct impact the area of interface has on most human endeavors. However, the interface is an inadequate source of information about the mechanisms which affect air quality. In situ sampling and measurements with an aircraft provide the necessary additional information by providing a view of the 3-dimensional distributions of air pollutants.

A knowledge of pollutant distributions adds to the value and meaning of data gathered by ground-based monitoring instruments. Such information can be used also to select optimum sites for surface monitors. A long-term airborne air quality monitoring project, incorporating a schedule of regular flights over the same paths, also makes the monitoring of air quality trends possible. Finally, the data gathered with an aircraft can be of value in regional scale model validation.

Wide-Area monitoring is the term applied to the program involving airborne air quality monitoring in the Western Energy Resource Development Area. Flights over a large area, as often as one a week, are planned for the Four Corners area. On a less regular basis, the aircraft is scheduled to be based in the Northern Great Plains where it can fly daily missions over a prescribed route in the region.

An EMSL-LV B-26 Monarch air quality monitoring aircraft is used to perform this monitoring task. The aircraft has the necessary range and is large enough to carry the required gaseous and particulate monitoring instrumentation.

Sulfur dioxide, ozone, and oxides of nitrogen are measured. However, with the exception of ozone, the concentrations of the gaseous pollutants monitored are expected to be near the minimum detectable limits of the instrumentation. Flights made to date bear out this expectation. Consequently, emphasis is placed on the study of fine particulates. In addition to these measurements, several meteorological and navigational parameters are monitored from this aircraft. A list of the airborne instruments is shown in Table 6.

TABLE 4. LABORATORIES IN SYSTEMS REVIEW AND QUARTERLY PERFORMANCE SURVEYS, QUALITY ASSURANCE PROGRAM

Arizona (Region IX)

Air Quality Division
Arizona State Department
of Health
Phoenix, Arizona

Colorado (Region VIII)

Air Pollution Control Division
Colorado Department of Health
4210 E. 11th Avenue
Denver, Colorado
(303) 288-6111, X241

Oil Shale Tract C-a
Rio Blanco Oil Shale Project
Denver, Colorado
Contractor:
EG G
Albuquerque, New Mexico

Oil Shale Tract C-b
Shell Oil Company
Denver, Colorado
Contractor:
Radian
Austin, Texas

Montana (Region VIII)

Air Quality Bereau
Department of Health and
Environmental Sciences
Cogswell Building
Helena, Montana 59601
(406) 587-3454

Yellowstone County Laboratory
Billings, Montana

Northern Testing Laboratory
Billings, Montana

New Mexico (Region VI)

State Of New Mexico
Environmental Improvement Agency
Albuquerque, New Mexico

North Dakota (Region VIII)

Division of Environmental
Engineering
State Department of Health
State Capitol
Bismarck, North Dakota 58501

South Dakota (Region VIII)

Air Quality
Department of Environmental
Protection
State Office Building 2
Pierre, South Dakota 57501
(605) 224-3351

Utah (Region VIII)

Air Quality Section
Bureau of Environmental Health
44 Medical Drive
Salt Lake City, Utah 84113
(801) 328-6108

Oil Shale Tract Ua Ub
SOHIO
Vernal, Utah
Contractor:
Aerovironment
Pasadena, California

Wyoming (Region VIII)

Air Quality Division
Department of Environmental Quality
State Office Building, West

Cheyenne, Wyoming 82002
(307) 777-7391

EPA

Environmental Research
Laboratory, Corvallis, Oregon
Air Quality Monitoring Trailer
Colstrip, Montana

Environmental Monitoring and Support
Laboratory, Las Vegas, Nevada
Aircraft Monitoring

NOAA

National Oceanic and Atmospheric
Administration
Atmospheric Physics and Chemical
Laboratory
Boulder, Colorado

UTE

Ute Research Laboratories
Fort Duchesne, Utah

Table 5. AIR QUALITY MONITORING STATIONS THAT RECEIVED INITIAL SITE VISITS

State	Location	Measurement	Agency
Arizona	Davis Dam	Part., NO_2, SO_2	State
Colorado	Oil Shale C-a	Part., NO_2, SO_2	Commercial
	Oil Shale C-b	Part., NO_2, SO_2	Commercial
	Grand Junction	Particulate	State
	Rifle	Particulate	State
	Grand Valley	Particulate	State
	Denver	Part., NO_2, SO_2, CO	State
Montana	Colstrip	Part., NO_2, SO_2	State
	Lame Deer	Particulate	State
	Billings	Part., NO_2, SO_2	State
New Mexico	Farmington	Part., NO_2, SO_2	State
	San Juan County	Part., NO_2, SO_2	State
	Shiprock	SO_2	State
	Kirkland	SO_2	State
North Dakota	Bismarck	Part., NO_2, SO_2	State
	Stanton	Part., NO_2, SO_2	State
	Beulah	Part., NO_2, SO_2	State
South Dakota	Rapid City	Part., SO_2	State
	Belle Fourche	Part., SO_2, NO_2	State
	Spearfish	Particulate	State
Utah	Huntington	Part., SO_2	State
	Price	Part., SO_2	State
	Oil Shale U-a, U-b	Part., SO_2, NO_2	Commercial
Wyoming	Rock Springs	Part., SO_2	State
	Gillette	Part., SO_2, NO_2	State
	Newcastle	Part., SO_2, NO_2	State

TABLE 6. INSTRUMENTS INSTALLED IN THE B-26 MONARCH AIRCRAFT

PARAMETER	METHOD	INSTRUMENT MANUFACTURE MODEL	TYPICAL OPERATING RANGE	MINIMUM DETECTABLE CONCENTRATION
Visibility (scattering)	Integrating Nephelometer	MRI 1550B	B_{scat} 0-10 x $10^{-4}m^{-1}$	0.2 x $10^{-4}m^{-1}$*
Nitric oxide	Chemiluminescent	TECO 14B (modified)	0-50 ppb	1 ppb*
Ozone	Chemiluminescent	Bendix 8002	0-500 ppb	5 ppb**
		Dasibi 1003-AAS	0-1000 ppb	8 ppb**
Sulfur dioxide	Pulsed Flourescence	TECO 43	0-500 ppb	2 ppb***
Temperature		Rosemount 102AU	---	---
Dew point		EG G 137C3	-50° C to +50° C	---
Altitude (pressure)		National Semiconductor	---	---
Position		Collins DME 40 and Bendix RVA-33-A VOR	---	
Hydrocarbons		Specially designed Bag Sampler	---	---
Condensation Nuclei	Automatic Cloud Chamber	Environment one Rich 100	300 - 10^7 particle cm^3	---
Particulate size Distribution	Two-stage impactor and final filter	Modified Sierra Instruments Model 4620C	Stage 1 - greater than 3.6 micrometers Stage 2 - greater than 0.65 micrometers After filter - greater than 0.1 micrometers	---

* Estimated from measurements made on actual instrument
** Source: Development and Testing of an Air Monitoring System, Research Triangle Institute
*** Source: ThermoElectron Corporation

For particulate measurements, the aircraft carries an integrating nephelometer, a condensation nuclei counter, and a three-stage size-fractionating sampler. The nephelometer and condensation nuclei counter offer sensitive real-time monitors of fine particulates, but are lacking in their ability to provide information which could be used to distinguish the probable sources of the particles measured. The size-fractionating sampler helps fill this void. This instrument provides two important parameters of interest in the study of particles--size distribution and composition. Size-distribution is made available through the sampler's ability to divide the particles into three distinct fractions by their aerodynamic size. The composition will be determined by a sensitive trace element analysis which will be performed on each of the three sample fractions. The analysis technique, an ion-excited x-ray emission analysis, will be conducted by the University of California at Davis. All elements of atomic number 11 and larger are simultaneously analyzed with a detectable limit from 10 to 200 nanograms per square centimenter of sample area.

MODELING PROGRAM

Air quality models are applied to nearly all the existing and proposed energy-related sources of air pollutants in the West to estimate their impact on the environment. These modeling efforts are performed by a variety of private and governmental organizations using a number of different techniques. These techniques are being inventoried and evaluated.

These modeling studies, while valuable, ahve two limitations: they are confined to the immediate environs of the source (usually within 10 kilometers) and the majority do not consider the possibility of the cumulative impact of several sources. A regional scale modeling effort is necessary to investigate the effects of emissions at some distance from their sources. Region VIII of the EPA is presently involved in such a program for the Northern Great Plains area through contractual agreement. The Region is investigating the long-range transport of pollutants from the larger power plants that exist in the area.

Environmental Research and Technology, Inc., has been awarded a contract to model the emissions in the Four Corners region. The contract which is being managed through the National Oceanic and Atmospheric Administration, Research Triangle Park, North Carolina, will be performed in two stages. The first stage, which is nearly complete, will consist of an examination of the state-of-the-art or regional scale modeling, and of a compilation of topographical, climatological, and air quality data. Various models and techniques are being assessed for their applicability to complex terrain, wet and dry removal processes, conversion of sulfur dioxide to sulfates, multiple emission sources, and their availability in the public domain. The models must cover spatial scales from 100 to 1,000 kilometers. The results of the modeling effort must give average hourly, maximum hourly, maximum 24-hour, and average annual surface concentration distribution of sulfur dioxide, sulfates, and particulate matter within 1,000 kilometers of the plant. The assessment of the various available models will clarify their

limitations and lead to the choice of those models which are best suited to meet the requirements. It is recognized that a single model cannot cover all the temporal requirements.

In the second stage of the study, models will be selected and applied to various meteorological, emission, and plant-siting scenarios defined by the emissions inventory. These scenarios include the effects of the proposed increase in emissions over the next 10 years and the various meteorological conditions that can exist. Data acquired from the Wide-Area Monitoring flights and from the ground-based sulfate network can be used to verify the models selected.

One goal of the modeling effort is to provide an estimate of the impact of future energy development in the Four Corners region. While pollutant levels are unlikely to reach the primary standards, there does exist the possibility of exceeding the significant deterioration regulations in the Class I areas in the region, such as the national parks. The modeling can be used to direct the energy development along the least detrimental path. A further use is to assess the deployment of the existing monitoring network and to develop a more effective monitoring system.

VISIBILITY MONITORING PROGRAM

Visibility degradation by the addition of large numbers of fine particulates to the air represents one of the most significant deterimental effects of energy development in the Western Energy Resource Development Area. Congress, through the Clean Air Act of 1977, has established as a national goal the elimination of visibility degradation in selected Class I areas. Many of these Class I areas are in the Western Energy Resource Development Area.

Light scattering by particles is the primary cause for visibility degradation. In a clean, dry atmosphere only the air molecules would scatter the light. If the light distribution and object were both ideal, the visual range in this clean air case would be about 350 kilometers. The addition of less then 10 micrograms per cubic meter of particulate matter into this atmosphere would cut the visual range in half. This same small increase in particulate loading in a dirtier atmosphere has a proportionately lesser effect on the visual range. In other words, pristine regions of the country as exist in many parts of the Western Energy Resource Development Area are much more vulnerable to drastic changes in visibility than regions normally carrying more particulate material.

All visibility monitoring techniques fall into three categories. These are contrast measurements, scattering measurements, and light transmission measurements. Each category is distinctive in the physical parameter monitored, yet each is related to the other and can provide a measure of visual range.

Since the eye is a contrast measurement instrument, all contrast monitoring techniques correlate well with human observation. A camera system can replace an observer and provide a permanent and more accurate record. The film is examined with a densitometer from which the contrast between the target object and background sky can be determined. The cost of processing and quality control, which is essential with the photographic techniques, can become somewhat restrictive. To avoid these problems, a photoelectric device in the focal plane of the optics allows a telephotometer to electronically process and record contrast measurements.

All contrast monitoring techniques, the eye included, are affected by non-pollutant related parameters. These include the distribution of light and the nature of the target object. The angle of the sun, amount and distribution of clouds, and the nature of other reflecting surfaces such as snow-covered areas will all influence a contrast measurement. This influence quite often will totally overwhelm any pollutant-related impacts on visibility. The reflective properties of the target, which if ideal would be totally non-reflective black, have similar large effects. Another deficiency in the contrast monitoring technique is the inability to operate at night, thus making it useless during a large portion of the day. This limits one's ability to investigate the phenomena controlling visibility degradation.

The scattering of light by airborne particles is the primary factor contributing to visibility degradation in the atmosphere. This then provides the basis for light-scattering measurement techniques. The principal instrument which employs this technique is an integrating nephelometer. Unlike contrast measurements which monitor over long paths, the nephelometer makes a point measurement which may not always be representative of visibility. A nephelometer is unaffected by the distribution of light or the nature of the target object. The visual range it determines is equivalent to the visual range under ideal lighting conditions to a "perfect black body" target.

Transmission measurements are also related to visibility. The ratio of the intensity of light which traversed a known distance of the atmosphere to the intensity of the light at its sources is the transmission. Many large airports have transmissometers for making this type of measurement. These have a short path length which results in accurate measurements only in the low visual ranges (0 to 30 kilometers). Extending the path length to extend the usable range has been done. However, in doing this, other non-visibility parameters begin to influence the measurement. Optical discontinuities (not related to pollutant discontinuities) tend to bend and break up the light beam. These effects are unnoticed over short distances but can cause problems in multi-kilometer paths. The EMSL-LV supported a month-long field study to demonstrate that a transmissometer can be designed to minimize the problems associated with these effects.

The EMSL-LV is developing a monitoring system which will use all of the more promising instrumental techniques for determining visual range. These visibility monitoring instruments are to be located at one site in central Utah where extensive side-by-side comparison and feasibility tests can be performed. The goals of this activity are to develop procedures for the

operation of each instrument to discover its limitations and utility, and finally gain insight into the phenomena controlling visibility in the vicinity of the station. The following instruments are being incorporated into this project: an integrating nephelometer; a long-path length transmissometer; an automatic and a manual telephotometer; a size-fractionating particulate sampler; and meteorological sensor for wind speed, wind direction, temperature, and humidity.

In addition to the visibility monitoring platform described above, the EMSL-LV is preparing to establish a small network of stations using manual telephotometers. This is being done in order that regional scale visibility phenomena can be studied and so that a data base of visual range values can be initiated. The National Park Service has agreed to operate manual telephotometers for the EPA in the parks of the Four Corners region. The planned network contains six sites located in Arizona and Utah. Both the monitoring platform and the regional network are scheduled to be in operation early in 1978.

WEATHER MODIFICATION EFFECTS OF ENERGY-RELATED AIR POLLUTION

Emissions from energy development activities may produce important though subtle effects on weather and climate. The normal variability of weather is such that a weather monitoring program designed to investigate inadvertent modifications of climate would require a trend analysis of data collected over a period of several decades. There is no question of the importance of this type of analysis, yet the development of energy resources cannot be slowed to keep pace with this type of impact assessment program. Another approach is required.

By studying the physical and chemical nature of energy-related emissions and merging this information with the state of knowledge of meteorological phenomena, it becomes possible to predict the impact of these emissions on the climate. The EPA is involved in a program to investigate the climate modification potential of energy-related emissions. This research is being conducted for the EPA by the National Oceanic and Atmospheric Administration.

The program is designed to investigate the two processes which are thought to be most influenced by air pollutants. They are the production or depletion of cloud and ice nuclei and the modification of the Earth's radiation balance. Cloud and ice nuclei particles are responsible for cloud and precipitation generation. The Earth's radiation balance is the phenomena which determine planetary cooling and heating.

Both airborne and ground-based measurements near typical energy emission sources are being made on a periodic basis. The field program is designed to investigate dispersion, coagulation, sedimentation, dry deposition, and washout to determine the residence times of aerosols. The gas-to-particle conversion processes particularly with respect to sulfate production is also being studied. By combining an Aitken nuclei counter, a diffusion cloud chamber and an ice nuclei counter, it is possible to determine not only total aerosol concentrations but the number fractions of cloud and ice condensation nuclei.

The effects of pollutants on short and long wave radiation are being evaluated by making measurements of the absorption and scattering by all pollutants plus the size-distribution and elemental composition of aerosol pollutants. A list of instruments used in the aircraft and ground-based systems is shown in Table 7. Plumes from two large coal-fired power plants, a copper smelter and a large urban area have been investigated to date as part of this study.

TABLE 7. LIST OF INSTRUMENTS NOAA AIRCRAFT

PARAMETER	METHOD	INSTRUMENT MANUFACTURE MODEL	TYPICAL OPERATING RANGE	MINIMUM DETECTABLE CONCENTRATION
CLOUD CONDENSATION NUCLEI	THERMAL DIFFUSION CHAMBER PHOTOGRAPHY	NOAA	20-2000 CM^{-3}	20 CM^{-3}
AITKEN NUCLEI	EXPANSION CHAMBER	ENVIRONMENT-ONE RICH 100	300 TO 10^7 CM^{-3}	1 x 10^2 CM^{-3}
LIGHT SCATTERING COEFFICIENT	INTEGRATING NEPHELOMETER	GARDNER 7000 4 G 2 MRI 1550	0 - 10 x $10^{-4}M^{-1}$	.15 x $10^{-4}M^{-1}$
TEMPERATURE	PLATINUM RESISTANCE	ROSEMOUNT 102 AN 1 AF	-40°C TO +40°C	
RELATIVE HUMIDITY	THERMOELECTRIC DEW POINT	GE 1011	-75°C TO 50°C	
OZONE	CHEMILUMINESCENCE	ML 8410	0 - 5 PPM	5.0 PPB
NITROGEN OXIDE	CHEMILUMINESCENCE	ML 8440	0 - 5 PPM	5.0 PPB
NITROGEN DIOXIDE	CHEMILUMINESCENCE	ML 8440	0 - 5 PPM	5.0 PPB
SULFUR DIOXIDE	UV PULSED FLUORESCENCE	TECO 43	0 - 5 PPM	2.0 PPB
AEROSOL FILTER SAMPLER	AEROSOL FILTRATION	NOAA SAMPLER, RCA TEM	5 - 10^6 CM^{-2}	5 CM^{-2}
AEROSOL FILTER SAMPLER	AEROSOL FILTRATION ICE CRYSTAL COUNTS	THERMAL DIFFUSION CHAMBER, NCAR	1 - 10^3 CM^{-2}	.1 CM^{-3}
AEROSOL SIZE	AEROSOL FILTRATION ELECTRON MICROSCOPY	NOAA SAMPLER RCA TEM		5.0 CM^{-3}
AEROSOL COMPOSITION	AEROSOL FILTRATION ELECTRON MICROSCOPY X-RAY SPECTROMETRY	NOAA SAMPLER COATES WELTER SEM KEVEX 5000		5.0 CM^{-3}
ICE NUCLEI	AEROSOL FILTRATION	THERMAL DIFFUSION CHAMBER, NCAR		.5 CM^{-3}
AEROSOL SIZE DISTRIBUTION	HE-NE LASER LIGHT SCATTERING	PARTICLE MEASURING SYSTEMS ASASP-X, FSSP	0.08-50μM	
POTENTIAL GRADIENT	ELECTRIC FIELD MILL	NOAA	0-10^6 VOLTS METER	1 VOLT METER
INFRARED RADIATION	BEAD THERMISTOR	BARNES, PRT-5	-20 - +75 C	

APPENDIX A

SUMMARY OF PRESENT AND PROPOSED FOSSIL FUEL ELECTRIC GENERATING FACILITIES AS OF JANUARY 1, 1977

Data Source:

Western System Coordinating Council
Reply to Federal Power Commission
Docket R-362, April 1, 1977

(Figures shown for all years indicate megawatts)

Abbreviations Used in Appendix A

AEPC - Arizona Electric Power Cooperative, Inc.
ANHM - City of Anaheim
APS - Arizona Public Service Company
BEPC - Basin Electric Power Cooperative
BHPL - Black Hills Power & Light Company
BURB - City of Burbank
C (Fuel Type) - Coal
C (Unit Type) - Combined cycle and/or combination of types
CCS - City of Colorado Springs
COL - City of Lamar
CPA - Cooperative Power Association
CSG - City of St. George
CUC - Citizens Utilities Company
CUEA - Colorado-Ute Electric Association
EPE - El Paso Electric Company
F - Fuel Type
G - Gas Type
GLEN - City of Glendale
I - Internal combustion or combustion turbine
IID - Imperial Irrigation District
LAS - Los Alamos Systems
LDWP - Los Angeles Department of Water & Power
LE - Lincoln Electric
MBM - Missouri Basin Municipal
MDU - Montana-Dakota Utilities Company
MPC - Montana Power Company
MPL - Minnesota Power & Light Company
NEVP - Nevada Power Company
NSP - Northern States Power Company
NWPS - Northwestern Public Service Company
O - Oil
OTP - Otter Trail Power Company
PASA - City of Pasadena
PEGT - Plains Electric Generation and Transmission Cooperative, Inc.
PGE - Portland General Electric Company
PNM - Public Service Company of New Mexico
PPL - Pacific Power & Light Company
PRPA - Platte River Power Authority
PSC - Public Service Company of Colorado
PSPL - Puget Sound Power & Light Company
S - Steam Turbine
SCE - Southern California Edison Company
SCPC - So. Colorado Power Division, Central Telephone Utility Corporation
SDGE - San Diego Gas & Electric Company
SNEV - State of Nevada
SRP - Salt River Project

T - Unit Type
TGE - Tucson Gas & Electric Company
TSGT - Tri-State G & T Association
UPA - United Power Association
UPLC - Utah Power & Light
USBR - Bureau of Reclamation
WWPC - Washington Water Power Company

PLANT NAME	LOCATION	UTILITY	F	T	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	TOTAL
ARIZONA																
Springerville	Springerville	TGE	C	S										312		312
Apache	Cochise	AEPC	CO	C	168		175	175								518
Coronado	St Johns	SRP	C	S				350	350							700
Cholla	Joseph City	APS	C	S	116		235	242	347			347				1287
Navajo	Page	SRP	C	S	2250											2250
Citizens	Nogales	CUC	O	I	3											3
Fairview	Douglas	APS	O	I	21											21
Axis	Yuma	SCE	O	I				23								23
Crosscut	Tempe	SRP	O	S	32											32
North Loop	Marana	TGE	O	I	98											98
Demoss Petrie	Tuscon	TGE	O	C	145											145
Yuma	Yuma	APS,SCE,IID	O	I	157											157
Kyrene	Tempe	SRP	O	C	284											284
San Tan	Gilbert	SRP	O	C	288											288
Saguaro	Red Rock	APS	O	C	324											324
Ocotillo	Tempe	APS	O	C	342											342
Phoenix	Phoenix	APS	O	C	445											445
Irvington	Tucson	TGE	O	C	496											496
Agua Fria	Glendale	SRP	O	C	596											596
COLORADO																
Durango	Durango	CuEA	C	S	5								-5			0
Bullock	Montrose	CUEA	C	S	12								-12			0

(Continued)

COLORADO (Continued)

PLANT NAME	LOCATION	UTILITY	F	T	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	TOTAL
Oliver	Somerset	CUEA	C	S	3								-3			0
Nucla	Nucla	CUEA	C	S	36											36
W.N. Clark	Canon City	SCPC	CG	S	43											43
Cameo	Grand Junction	PSC	C	S	76											76
Rawhide	Wellington	PRPA	C	S									200			200
Arapahoe	Denver	PSC	C	S	236											236
Martin Drake	Colorado Springs	CCS	C	S	297				-6							291
Ray D. Nixon	Fountain	CCS	C	S					200					200		400
Hayden	Hayden	CUEA	C	S	436											436
Valmont	Boulder	PSC	CGO	C	304			171		8						483
Pawnee	Fort Morgan	PSC	C	S					500							500
Comanche	Pueblo	PSC	C	S	700											700
Cherokee	Denver	PSC	C	S	709											709
Southeastern	Southeastern	PSC	C	S									500		500	1000
Craig	Craig	CUEA, SRP, TSGT, PRPA	C	S				760			380	380				1520
Pagosa	Pagosa Springs	CUEA	O	I	2				-2							0
Rocky Ford	Rocky Ford	SCPC	OG	C	18											18
Fruita	Fruita	PSC	O	I	19											19
Alamosa	Alamosa	PSC	O	C	34	21										55
Fort Lupton	Fort Lupton	PSC	O	I	90											90
Burlington	Burlington	TSGT	O	I		102										102

(Continued)

PLANT NAME	LOCATION	UTILITY	F	T	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	TOTAL
COLORADO (Continued)																
Zuni	Denver	PSC	O	S	107											107
Republican	Wray	TSGT	O	I	216											216
Delta	Delta	USBR	G	I	5											5
Lamar	Lamar	COL	G	S	41											41
Pueblo	Pueblo	SCPC	GO	C	45											45
George Birdsall	Colorado Springs	CCS	G	S	57											57
MONTANA																
Lewis and Clark	Sidney	MDU	C	S	51											51
Corette	Billings	MPC	C	S	180											180
Colstrip	Colstrip	MPC, PSPL, PGE, WWPC, PPL	C	S	660				700	700						2060
Libby Turbine	Libby	PPL	O	I	28											28
Bird	Billings	MPC	O	S	70											70
Miles City	Miles City	MDU	G	I	29											29
Glendive	Glendive	MDU	G	S	7			29								36
NEVADA																
Reid Gardner	Moapa	NEVP	C	S	330											330
Allen	Las Vegas	NEVP	C	S											500	500
Mohave	Lauflin	SCE,SDGE, LDWP,NEVP, SRP	C	S	1580											1580

(Continued)

NEVADA (Continued)

PLANT NAME	LOCATION	UTILITY	F	T	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	TOTAL
Westside Diesels	Las Vegas	NEVP	O	I	30											30
Stauffer Chemical	Henderson	SNEV	G	C	25											25
Sunrise	Las Vegas	NEVP	G	C	152											152
Clark	Las Vegas	NEVP	G	C	252											252
Gas Turbine	Las Vegas	NEVP	G	I			70	70	70	70						280
NEW MEXICO																
San Juan	Water Flow	PNM,TGE	C	S	660	-32		486		450						1564
Four Corners	Farmington	SCE,APS,PNM, SRP,EPE,TGE	C	S	2167	5										2172
Santa Fe	Santa Fe	PNM	G	S	13										-13	0
Prager	Albuquerque	PNM	G	S	32	-6		-14		-12						0
Los Alamos	Los Alamos	LAS	G	S	16											16
Las Vegas	Las Vegas	PNM	G	I	20											20
Farmington	Farmington	USBR	G	S	30											30
Algodones	Algodones	PEGT	G	S	45											45
Person	Albuquerque	PNM	G	S	114											114
Reeves	Albuquerque	PNM	G	S	175											175
NORTH DAKOTA																
Williams J. Neal	Voataire	BEPC	C	S	36								-36			0
Knife River	Beulah	MDU	C	S	6											6
Dakota	Beulah	MDU	C	S	8											8

(Continued)

NORTH DAKOTA (Continued)

PLANT NAME	LOCATION	UTILITY	F	T	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	TOTAL
Franklin P. Wood	Grand Forks	MPC	C	S	23											23
Heskett	Mandan	MDU	C	S	101											101
Stanton	Stanton	UPA	C	S	167											167
Coyote	Beulah	OTP,MPC MDU,NWPS,MPL	C	S						412						412
Milton R. Young	Center	MPL,MPC	C	S	240	408										648
Leland Olds	Stanton	BEPC	C	S	650											650
Antelope Valley	Beulah	BEPC	C	S					416				416			832
Coal Creek	Underwood	CPA,UPA	C	S			469	466								935

SOUTH DAKOTA

Lawrence	Sioux Falls	NSP	C	S	45	-45										45
Mitchell	Mitchell	NWPS	C	S	9		-9									0
Mobridge	Mobridge	MDU	C	S	11	-9										2
Aberdeen	Aberdeen	NWPS	C	S	8		20									28
Kirk	Lead	BHPL	C	S	31											31
Ben French	Rapid City	BHPL	CO	C	32	54	27	27								140
Big Stone	Big Stone Lake	OTP, MDU,NWPS	C	S	440	13										453
Woonsocket	Woonsocket	NWPS	O	I	1											1
Highmore	Highmore	NWPS	O	I	2											2
Salem	Salem	NSP	O	I	2											2
Faulkton	Faulkton	NWPS	O	I	3											3

(Continued)

SOUTH DAKOTA (Continued)

PLANT NAME	LOCATION	UTILITY	F	T	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	TOTAL
Clark	Clark	NWPS	O	I	3											3
Webster	Webster	NWPS	O	I	3											3
Redfield	Redfield	NWPS	O	I	4											4
Armour	Armour	NWPS	O	I	4											4
Chamberlain	Chamberlain	NWPS	O	I	7											7
Yankton Old	Yankton	NWPS	O	I	7											7
Yankton New	Yankton	NWPS	O	I	11											11
Huron	Huron	NWPS	O	I	15											15
Pathfinder	Sioux Falls	NSP	O	S	65											65
Spirit Mound	Gayville	BEPC	O	I			120									120

UTAH

Cal. Pac. Util. Co.	Cedar City	UPLC	C	S	7											7
Hale	Orem	UPLC	C	S	63											63
Carbon	Castle Gate	UPLC	C	S	171											171
Gadsby	Salt Lake City	UPLC	CG	S	246											246
Warner Valley	St. George	LDWP NEVP,CSG	C	S									250	250		500
Nephi	Nephi	UPLC	C	S											500	500
Intermountain	Wayne County	LDWP ANHM,BURB GLEN,PASA	C	S											750	750
Emery	Emery	UPLC	C	S			400		400							800
Huntington	Huntington	UPLC	C	S	415	400										815
Jordan	Salt Lake City	UPLC	O	S	24•											24

(Continued)

PLANT NAME	LOCATION	UTILITY	F	T	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	TOTAL
UTAH (Continued)																
Logan City	Logan	USBR	G	I	4											4
Murray City	Murray	USBR	G	I	7											7
Bountiful City	Bountiful	USBR	G	I	8											8
Provo City	Provo	USBR	G	S	14											14
Little Mountain	Ogden	UPCL	G	I	15											15
WYOMING																
Neil Simpson	Wyodak	BHPL	C	S	23											23
Osage	Osage	BHPL	C	S	31											31
Wyodak	Gillette	PPL,BHPL	C	S			330					330				660
Dave Johnston	Glenrock	PPL	C	S	750											750
Laramie	Wheatland	BEPC,TSGT MBM,LE	C	S					500			500				1000
Naughton	Kemmerer	UPLC	C	S	710						400		400			1510
Jim Bridger	Rock Springs	PPL,IPC	C	S	1500			500								2000
Lake	Yellowstone Park	MPC	O	I	3											3
Corlett	Cheyenne	PSC	O	I	3											3
Cheyenne	Cheyenne	PSC	O	I	10											10
Trona	Green River	PPL	G	S	15											15

APPENDIX B

AIR QUALITY MONITORING STATIONS

Data Source:

U.S. Environmental Protection Agengy
Air Quality Data System (SAROAD), December 1975
and from
Private Communications between
Environmental Monitoring and Support Laboratory-Las Vegas
and
EPA Regions VI, VIII and IX

ARIZONA

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
1	AJO	6	-	X	-	X	X	X	X	B*	-	-	-	-
2	Chandler	1	X	-	-	-	X	X	X	-	-	-	-	-
3	Claypool	1	-	X	-	-	-	-	-	C**	-	-	-	-
4	Clifton	2	-	X	-	-	-	-	-	C	-	-	-	-
5	Douglas	4	X	X	-	X	X	X	X	CB	-	-	-	-
6	Page	1	-	-	X	-	X	X	X	B	B	-	-	-
7	Hayden	4	-	X	-	X	X	X	X	B	-	-	-	-
8	Paradise Valley	2	X	-	-	-	X	X	X	-	-	-	-	-
9	Phoenix	9	X	-	-	-	X	X	X	BC	C	X	-	X
10	Carefree	2	X	-	X	-	X	X	X	-	-	-	-	-
11	St. Johns	1	X	-	-	-	X	X	X	-	-	-	-	-
12	Guadalupe	1	X	-	-	-	X	X	X	-	-	-	-	-
13	Mesa	1	X	-	-	-	X	X	X	-	-	-	-	-
14	Miami	4	-	X	-	X	X	X	X	B	B	-	-	-
15	Davis Dam	1	-	X	-	-	X	X	X	B	B	-	-	-
16	Katherine's Landing	1	-	X	-	-	X	-	-	-	-	-	-	-
17	Mineral Park	1	-	X	-	-	-	-	-	B	-	-	-	-
18	Florence	1	-	X	-	-	X	X	X	B	B	-	-	-
19	Sun City	1	X	-	-	-	X	X	X	-	-	-	-	-
20	Tucson	12	X	-	-	-	X	-	-	C	C	X	X	-
21	Winslow	1	-	-	X	-	X	X	X	-	-	-	-	-
22	Clarkdale	1	-	X	-	-	X	X	X	-	-	-	-	-
23	Camp Verde	1	-	-	X	-	X	X	-	-	-	-	-	-
24	Yuma	1	X	-	-	-	X	X	X	-	-	X	X	-
25	Eager	1	X	-	-	-	X	X	X	-	-	-	-	-
26	Casa Grande	1	X	-	-	-	X	X	X	-	-	-	-	-
27	St. David	1	-	X	-	-	-	-	-	-	B	-	-	-
28	Flagstaff	1	X	-	-	-	X	X	X	-	-	-	-	-

(Continued)

ARIZONA (Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
29	Winkelman	1	-	X	-	-	-	-	-	C	-	-	-	-
30	Glendale	1	X	-	-	-	X	X	X	C	-	X	X	-
31	Grand Canyon	1	-	-	X	-	X	X	X	B	B	-	-	-
32	Near Morenci	1	-	X	-	-	X	X	X	C	-	-	-	-
33	Kingman	1	X	-	-	-	X	X	X	-	-	-	-	-
34	Litchfield	1	X	-	-	-	X	X	X	-	C	X	X	-
35	Lake Havasu	1	X	-	-	-	X	X	X	-	-	-	-	-
36	Show Low	1	X	-	-	-	X	X	X	-	-	-	-	-
37	Nogales	1	X	-	-	-	X	X	X	-	-	-	-	-
38	Green Valley	1	X	-	-	-	X	-	-	-	-	-	-	-
39	Corona de Tucson	1	-	-	X	-	X	-	-	-	-	-	-	-
40	Rillito	2	-	X	-	-	X	X	X	-	-	-	-	-
41	Pima	1	X	-	-	-	X	-	-	-	-	-	-	-
42	Saguaro Nat. Monument	1	X	-	-	-	-	-	-	C	-	-	-	-
43	San Manuel	2	-	X	-	-	X	X	X	C	-	-	-	-
44	Prescott	1	X	-	-	-	X	X	X	-	-	-	-	-
45	Safford	1	X	-	-	-	X	X	X	-	-	-	-	-
46	Scottsdale	4	X	-	-	-	X	X	X	-	-	X	X	-
47	Sierra Vista	2	X	-	-	-	X	X	X	-	-	-	-	-
48	South Tucson	1	X	-	-	-	X	X	X	-	-	-	-	-
49	Superior	1	X	-	-	-	X	X	X	-	-	-	-	-
50	Redrock †	1	-	-	X	-	X	-	-	-	-	-	-	-
51	Teec Nos Pos †	1	-	-	X	-	X	-	-	-	-	-	-	-
52	Keams Canyon †	1	-	-	X	-	X	-	-	-	-	-	-	-
53	Tuba City †	1	-	-	X	-	X	-	-	-	-	-	-	-
54	Cedar Ridge †	1	-	-	X	-	X	-	-	-	-	-	-	-
55	Copper Mine †	1	-	-	X	-	X	-	-	-	-	-	-	-

(Continued)

ARIZONA (Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
56	Lechee †	1	-	-	X	-	X	-	-	-	-	-	-	-
57	Kaibeto †	1	-	-	X	-	X	-	-	-	-	-	-	-
58	Tsa Shizzi Rock †	1	-	-	X	-	X	-	-	-	-	-	-	-
59	Pipe Springs Nat. Monument †	1	-	-	X	-	X	-	-	-	-	-	-	-
60	Lee's Ferry †	1	-	-	X	-	X	-	-	-	-	-	-	-

COLORADO

1	Adams City	1	X	-	-	-	X	X	-	-	-	-	-	-
2	Alamosa	1	X	-	-	-	X	X	-	-	-	-	-	-
3	Arvada	2	X	-	-	-	X	X	-	C	-	X	X	X
4	Aurora	1	X	-	-	-	X	X	-	-	-	-	-	-
5	Boulder	1	X	-	-	-	X	X	-	-	-	-	-	-
6	Brighton	1	X	-	-	-	X	X	-	-	-	-	-	-
7	Canon City	1	X	-	-	-	X	X	-	-	-	-	-	-
8	Idaho Springs	1	X	-	-	-	X	X	-	-	-	-	-	-
9	Colorado Springs	1	X	-	-	-	X	X	-	-	-	-	-	-
10	Craig	1	X	-	-	-	X	X	-	-	-	-	-	-
11	Delta	1	X	-	-	-	X	X	-	-	-	-	-	-
12	Denver	9	X	X	-	-	X	X	X	C	C	X	X	X
13	Castle Rock	1	X	-	-	-	X	X	-	-	-	-	-	-
14	Durango	1	X	-	-	-	X	X	-	-	-	-	-	-
15	Vail	1	X	-	-	-	X	X	-	-	-	-	-	-
16	Edgewater	1	X	-	-	-	X	X	-	-	-	-	-	-
17	Englewood	1	X	-	-	-	X	X	-	-	-	-	-	-
18	Florence	1	X	-	-	-	X	X	-	-	-	-	-	-
19	Fort Collins	1	X	-	-	-	X	X	-	-	-	-	-	-

(Continued)

COLORADO (Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
20	Rifle	1	X	-	-	-	X	X	-	-	-	-	-	-
21	Grand Valley	1	X	-	-	-	X	X	-	-	-	-	-	-
22	Blackhawk	1	X	-	-	-	X	X	-	-	-	-	-	-
23	Glenwood Springs	1	X	-	-	-	X	X	-	-	-	-	-	-
24	Golden	1	X	-	-	-	X	X	-	-	-	-	-	-
25	Kremmling	1	X	-	-	-	X	X	-	-	-	-	-	-
26	Grand Junction	1	X	-	-	-	X	X	-	-	-	-	-	-
27	Greeley	2	X	-	-	-	X	X	-	-	-	-	-	-
28	Gunnison	1	X	-	-	-	X	X	-	-	-	-	-	-
29	Rocky Flats	1	-	X	-	-	X	X	-	-	-	-	-	-
30	La Junta	1	X	-	-	-	X	X	-	-	-	-	-	-
31	Lakewood	1	X	-	-	-	X	X	-	-	-	-	-	-
32	Red Mesa †	2	-	-	X	-	X	X	-	-	-	-	-	-
33	La Porta	1	X	-	-	-	X	X	-	-	-	-	-	-
34	Littleton	1	X	-	-	-	X	X	-	-	-	-	-	-
35	Longmont	1	X	-	-	-	X	X	-	-	-	-	-	-
36	Loveland	1	X	-	-	-	X	X	-	-	-	-	-	-
37	Manitou Springs	1	X	-	-	-	X	X	-	-	-	-	-	-
38	Fruita	1	X	-	-	-	X	X	-	-	-	-	-	-
39	Palisade	1	X	-	-	-	X	X	-	-	-	-	-	-
40	Mesa Verde Nat. Park	2	-	-	X	-	X	-	-	-	-	-	-	-
41	Montrose	1	X	-	-	-	X	X	-	-	-	-	-	-
42	Aspen	1	X	-	-	-	X	X	-	-	-	-	-	-
43	Pueblo	2	X	-	-	-	X	X	-	-	-	-	-	-
44	Meeker	1	X	-	-	-	X	-	-	-	-	-	-	-
45	Rangely	1	X	-	-	-	X	-	-	-	-	-	-	-
46	Black Sulfer Creek	1	-	-	X	-	X	-	-	-	-	-	-	-
47	Rocky Ford	1	X	-	-	-	X	X	-	-	-	-	-	-
48	Hayden	1	X	-	-	-	X	X	-	-	-	-	-	-

(Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
COLORADO (Continued)														
49	Steamboat Springs	2	X	-	-	-	X	X	-	-	-	-	-	-
50	Sterling	1	X	-	-	-	X	X	-	-	-	-	-	-
51	Trinidad	1	X	-	-	-	X	X	-	-	-	-	-	-
52	Walsenburg	1	X	-	-	-	X	X	-	-	-	-	-	-
53	Welby	1	X	-	-	-	-	-	-	C	-	X	X	X
54	Windsor	1	X	-	-	-	X	X	-	-	-	-	-	-
55	Johnstown	1	X	-	-	-	X	X	-	-	-	-	-	-
56	La Salle	1	X	-	-	-	X	-	-	-	-	-	-	-
57	Platteville	1	X	-	-	-	X	-	-	-	-	-	-	-
58	Westminster	1	X	-	-	-	X	X	-	-	-	-	-	-
59	Cortez †	1	X	-	-	-	X	-	-	-	-	-	-	-
60	Towaoc †	1	-	-	X	-	X	-	-	-	-	-	-	-
61	Ignacio †	1	-	-	X	-	X	-	-	-	-	-	-	-
NEVADA (Clark County)														
1	Boulder City	1	X	-	-	-	X	-	-	-	-	-	-	-
2	Las Vegas	11	X	X	X	-	X	-	-	-	BC	X	X	-
3	Logandale	1	X	-	-	-	X	-	-	-	-	-	-	-
4	Arden	1	X	-	-	-	X	-	-	-	-	-	-	-
5	Katherine's Landing	1	-	X	-	-	X	-	-	-	-	-	-	-
6	Henderson	3	X	X	-	-	X	-	-	C	-	-	-	-
7	North Las Vegas	2		X	-	-	A	X	-	-	-	-	-	-
NEW MEXICO														
1	Alamogordo	2	X	-	X	-	X	-	-	-	-	-	-	-
2	Albuquerque	9	X	X	-	-	X	X	X	B	B	-	-	-
3	Aztec	1	-	X	-	-	X	-	-	-	-	-	-	-
4	Bayard	2	X	-	-	-	X	-	-	BC	-	-	-	-

(Continued)

NEW MEXICO (Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
5	Bernalillo Co.	3	X	-	-	-	X	X	-	-	-	-	-	-
6	Alameda	2	X	-	-	-	X	X	-	-	-	X	-	-
7	Carlsbad	3	X	X	-	-	X	-	-	C	-	-	-	-
8	Deming	1	-	X	-	-	X	-	-	B	-	-	-	-
9	Anthony	1	-	X	-	-	X	-	-	B	-	-	-	-
10	Sun Land Park	1	-	X	-	-	X	-	-	B	-	-	-	-
11	Afton	1	-	-	X	-	X	-	-	-	-	-	-	-
12	Hatch	1	-	-	X	-	X	-	-	-	-	-	-	-
13	La Union	1	-	X	-	-	-	-	-	-	-	X	-	-
14	Farmington	4	X	X	-	-	X	-	-	C	C	-	X	-
15	Gallup	1	X	-	-	-	X	-	-	-	-	-	-	-
16	Hurley	2	-	X	-	-	-	-	-	B	-	-	-	-
17	Animas	1	-	-	X	-	X	-	-	B	-	-	-	-
18	Las Cruces	6	X	X	-	-	X	-	-	BC	-	X	X	-
19	Lea Co.	1	-	X	-	-	X	-	-	-	-	-	-	-
20	Lordsburg	1	-	X	-	-	X	-	-	B	-	-	-	-
21	Los Alamos	1	X	-	-	-	X	-	-	-	-	-	-	-
22	White Rock	1	-	X	-	-	X	-	-	-	-	-	-	-
23	Shiprock	3	-	X	-	-	X	-	-	C	-	-	-	-
24	San Juan Co.	1	-	X	-	-	X	-	-	-	-	-	-	-
25	La Plata	1	-	X	-	-	X	-	-	B	-	-	-	-
26	Kirtland	2	-	X	-	-	X	-	-	BC	-	-	-	-
27	Near Teec Nos Pos	1	-	X	-	-	X	-	-	C	-	-	-	-
28	Santa Fe	5	X	-	-	X	X	-	-	B	-	-	X	-
29	Truth or Consequences	1	X	-	-	-	X	-	-	-	-	-	-	-
30	Artesia	1	X	-	-	-	X	-	-	B	-	-	-	-
31	Belen	1	X	-	-	-	X	-	-	-	-	-	-	-
32	Clovis	1	X	-	-	-	X	-	-	-	-	-	-	-
33	Anapra	1	-	X	-	-	-	-	-	C	-	-	-	-

(Continued)

NEW MEXICO (Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
34	Organ	1	-	-	X	-	-	-	-	B	-	-	-	-
35	Espanola	2	X	-	-	-	X	-	-	-	-	-	-	-
36	Eunice	1	-	X	-	-	X	-	-	B	-	-	-	-
37	Hachita	1	-	-	X	-	X	-	-	-	-	-	-	-
38	Grant Co.	1	-	-	-	X	-	-	-	B	-	-	-	-
39	Grants	1	X	-	-	-	X	-	-	-	-	-	-	-
40	Mosquero	1	-	X	-	-	X	-	-	-	-	-	-	-
41	Hidalgo Co.	1	-	X	-	-	-	-	-	C	-	-	-	-
42	Hobbs	3	X	X	-	-	X	-	-	BC	-	-	-	-
43	Jal	1	X	-	-	-	X	-	-	B	-	-	-	-
44	Las Vegas City	1	X	-	-	-	X	-	-	-	-	-	-	-
45	Lovington	1	-	X	-	-	X	-	-	B	-	-	-	-
46	Milan	1	X	-	-	-	X	-	-	-	-	-	-	-
47	Raton	1	X	-	-	-	X	-	-	B	-	-	-	-
48	Roswell	2	X	-	-	-	X	-	-	B	-	-	X	-
49	Silver City	1	X	-	-	-	X	-	-	B	-	-	-	-
50	Socorro	2	X	-	-	-	X	-	-	B	-	-	-	-
51	Taos	1	X	-	-	-	X	-	-	-	-	-	-	-
52	Tucumcari	1	X	-	-	-	X	-	-	-	-	-	-	-
53	Paguate	1	-	X	-	-	X	-	-	-	-	-	-	-
54	Bosque Farms	1	X	-	-	-	X	-	-	-	-	-	-	-
55	Burnham †	1	-	-	X	-	X	-	-	-	-	-	-	-
56	Dulce †	1	-	-	X	-	X	-	-	-	-	-	-	-
57	Huerfano †	1	-	-	X	-	X	-	-	-	-	-	-	-
58	Tohatchi †	1	-	-	X	-	X	-	-	-	-	-	-	-

NORTH DAKOTA

1	Bismark	1	X	-	-	-	X	X	X	B	B	-	-	-
2	Cass Co.	1	-	-	X	-	X	X	X	-	-	-	-	-
3	Devils Lake	1	X	-	-	-	X	X	X	-	-	-	-	-

(Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
	NORTH DAKOTA (Continued)													
4	Dickinson	1	X	-	-	-	X	X	X	-	-	-	-	-
5	Fargo	2	X	-	-	-	X	X	X	-	-	-	-	-
6	Grand Forks	2	X	-	-	-	X	X	X	-	-	-	-	-
7	Jamestown	2	X	-	X	-	X	X	X	-	-	-	-	-
8	Mandan	1	X	-	-	-	X	X	X	-	-	-	-	-
9	Minot	1	X	-	-	-	X	X	X	-	-	-	-	-
10	Valley City	1	X	-	-	-	X	X	X	-	-	-	-	-
11	Wahpeton	1	X	-	-	-	X	X	X	-	-	-	-	-
12	Lake Darling	1	-	-	X	-	X	X	X	-	-	-	-	-
13	Williston	1	X	-	-	-	X	X	X	-	-	-	-	-
14	Beulah	2	X	-	-	-	X	X	X	B	B	-	-	-
15	Parshall	1	-	-	X	-	X	-	-	-	-	-	-	-
16	Garrison	1	-	-	X	-	X	-	-	-	-	-	-	-
17	Washburn	1	-	-	X	-	X	-	-	B	B	-	-	-
18	McClusky	2	-	-	X	-	X	-	-	-	-	-	-	-
19	Bowman	1	-	-	X	-	X	-	-	-	-	-	-	-
20	Stanton	1	-	-	X	-	X	-	-	BC	BC	-	-	-
21	Mott	1	-	-	X	-	X	-	-	B	B	-	-	-
22	Mendora	1	-	-	X	-	X	-	-	-	-	-	-	-
23	Mary Vale	1	-	-	X	-	X	X	X	-	-	-	-	-
	MONTANA													
1	Anaconda	1	-	-	-	X	-	-	-	BC	-	-	-	-
2	Bighorn Co.	1	-	-	X	-	X	-	-	-	-	-	-	-
3	Billings	8	X	X	-	X	X	-	-	C	C	X	X	X
4	Butte	5	X	X	-	-	X	-	-	-	-	-	-	-
5	Columbia Falls	1	X	-	-	-	X	-	-	-	-	-	-	-
6	Deer Lodge Co.	2	X	-	-	X	-	-	-	BC	-	-	-	-
7	Glacier Nat. Park	1	-	-	X	-	X	-	-	B	-	-	-	-

(Continued)

MONTANA (Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
8	Phillipsburg	1	-	X	-	-	X	-	-	-	-	-	-	-
9	Great Falls	2	X	X	-	-	X	-	-	B	B	-	-	-
10	Helena	4	X	X	-	X	X	-	-	BC	-	-	-	-
11	Saddle Mountain	1	-	X	-	-	-	-	-	B	-	-	-	-
12	Jefferson Co.	1	-	-	-	X	-	-	-	B	-	-	-	-
13	Kalispell	2	-	X	-	-	X	-	-	-	-	-	-	-
14	Laurel	2	-	X	-	-	X	-	-	-	-	-	-	-
15	Missoula	1	X	-	-	-	X	X	X	-	-	-	-	-
16	Missoula Co.	5	X	-	-	-	X	X	X	-	-	-	-	-
17	Garrison	1	-	X	-	-	X	-	-	-	-	-	-	-
18	Colstrip	2	-	-	X	-	X	-	-	BC	BC	X	X	X
19	Columbia Gardens	1	-	X	-	-	X	-	-	-	-	-	-	-
20	Warm Springs	1	-	-	-	-	-	-	-	BC	BC	-	-	-
21	Fort Howes	1	-	-	X	-	X	-	-	-	-	-	-	-
22	Ekalaka	1	-	-	X	-	X	-	-	-	-	-	-	-
23	Glendive	1	-	-	X	-	X	-	-	-	-	-	-	-
24	Lindsay	2	-	-	X	-	X	-	-	-	-	-	-	-
25	Fort Peck	1	-	-	X	-	X	-	-	B	B	-	-	-
26	Broadus	1	-	-	X	-	X	-	-	-	-	-	-	-
27	Poplar	1	-	-	X	-	X	-	-	-	-	-	-	-
28	Lame Deer	1	-	-	X	-	X	-	-	B	B	-	-	-
29	Libby	1	X	-	-	-	X	-	-	-	-	-	-	-
30	Decker	1	-	-	X	-	X	-	-	-	-	-	-	-
31	Scobey	1	-	-	-	-	X	-	-	-	-	-	-	-
32	Cascade Co.	1	X	-	-	-	X	-	-	-	-	-	-	-
33	Flathead Co.	1	-	X	-	-	X	-	-	-	-	-	-	-
34	Polson	1	-	X	-	-	X	-	-	-	-	-	-	-
35	Lake Co.	1	-	X	-	-	X	-	-	-	-	-	-	-

SOUTH DAKOTA

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
1	Black Hills Nat. Forest	1	-	-	X	-	X	X	X	B	B	-	-	-
2	Pierre	1	X	-	-	-	X	-	-	-	-	-	-	-
3	Rapid City	4	X	X	-	-	X	-	-	B	-	-	-	-
4	Sioux Falls	3	X	-	-	-	X	-	-	-	-	-	-	-
5	Belle Fourche	1	-	-	X	-	X	-	-	B	B	-	-	-
6	Deerfield	1	-	-	X	-	X	-	-	-	-	-	-	-
7	Spearfish	1	-	X	-	-	X	-	-	-	-	-	-	-
8	Hot Springs	1	-	-	X	-	X	-	-	-	-	-	-	-
9	Brookings	1	X	-	-	-	X	-	-	-	-	-	-	-
10	Huron	1	X	-	-	-	X	-	-	-	-	-	-	-
11	Mitchell	1	X	-	-	-	X	-	-	-	-	-	-	-
12	Buffalo	2	-	-	X	-	X	-	-	B	B	-	-	-
13	Lemmon	2	-	-	X	-	X	-	-	-	-	-	-	-
14	Watertown	1	X	-	-	-	X	-	-	-	-	-	-	-
15	Yankton	1	-	-	X	-	X	-	-	-	-	-	-	-
16	Aberdeen	1	X	-	-	-	X	-	-	-	-	-	-	-
17	Redig	1	-	-	X	-	X	-	-	-	-	-	-	-
18	Mobridge	3	-	X	-	-	X	-	-	-	-	-	-	-

UTAH

1	Glen Canyon	1	-	-	X	-	X	-	-	-	-	-	-	-
2	Glen Canyon City †	1	-	-	X	-	X	-	-	-	-	-	-	-
3	Kearns	1	X	-	-	-	X	-	-	C	-	-	-	-
4	Magna	4	-	X	-	X	-	-	-	C	C	X	X	-
5	Ogden	1	X	-	-	-	X	X	X	C	C	X	X	-
6	Provo	1	X	-	-	-	X	-	-	C	C	X	X	-
7	Salt Lake City	3	X	-	-	-	X	-	X	C	C	X	X	X
8	Cedar City	1	X	-	-	-	X	-	-	C	-	-	-	-
9	Woods Cross	1	-	-	-	X	X	-	-	C	C	X	X	X

(Continued)

UTAH (Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
10	Lehi	1	-	-	-	-	X	-	-	C	-	-	-	-
11	Tooele	1	-	-	-	-	X	-	-	C	-	-	-	-
12	Pleasant Grove	1	-	-	-	-	X	-	-	-	-	-	-	-
13	Orem	1	-	-	-	-	X	-	-	-	-	-	-	-
14	Carbon Co.	1	-	X	-	-	X	-	-	C	-	-	-	-
15	Emery Co. †	3	-	-	X	-	X	-	-	X	X	-	-	-
16	Escalante †	1	-	-	X	-	X	-	-	X	X	-	-	-
17	Henrieville †	1	-	-	X	-	X	-	-	-	-	-	-	-
18	Price	1	X	-	-	-	X	-	-	C	-	-	-	-
19	St. George †	1	-	-	X	-	X	-	-	X	X	-	-	-
20	Navajo Mt. †	1	-	-	X	-	X		-	-	-	-	-	-
21	Aneth †	1	-	-	X	-	X	-	-	-	-	-	-	-
22	Oljato Train Rock †	1	-	-	X	-	X	-	-	-	-	-	-	-
23	Bloomington †	1	-	-	X	-	X	-	-	-	-	-	-	-
24	Cainville	1	-	-	-	-	X	-	-	-	-	-	-	-
25	Vernal	1	-	-	-	-	X	-	-	-	-	-	-	-
26	Bountiful	1	X	-	-	-	-	-	-	C	C	X	X	-

WYOMING

1	Casper	1	X	-	-	-	X	X	X	B	B	-	-	-
2	Cheyenne	1	X	-	-	-	X	X	X	B	B	-	-	-
3	Converse Co.	1	-	-	X	-	X	-	-	-	-	-	-	-
4	Grand Teton Nat. Park	1	-	-	X	-	X	X	X	-	-	-	-	-
5	Laramie	1	-	X	-	-	X	-	-	-	-	-	-	-
6	Riverton	1	X	-	-	-	X	-	-	B	B	-	-	-
7	Rock Springs	3	X	-	-	-	X	-	-	B	-	-	-	-
8	Granger	1	X	-	-	-	X	-	-	-	-	-	-	-
9	Yellowstone Nat. Park	1	-	-	X	-	X	-	-	B	B	-	-	-
10	Douglas (40 mi. north)	2	X	-	-	-	X	-	-	-	-	-	-	-

(Continued)

WYOMING (Continued)

Map No.	Location	No. of Stations	Surveillance Classification				Type of Measurement							
			Population	Source	Background	Special Study	TSP	Trace Anal.	Sulfate	SO_2	NO_2	O_3	CO	HC
11	Torrington	1	X	-	-	-	X	-	-	-	-	-	-	-
12	Gillette	2	X	-	X	-	X	-	-	BC	BC	-	-	-
13	Newcastle	3	X	-	X	-	X	-	-	B	B	-	-	-
14	Washakie Co.	1	X	-	-	-	X	-	-	-	-	-	-	-
15	Lovell	1	X	-	-	-	X	-	-	-	-	-	-	-
16	Afton	2	X	-	-	-	X	-	-	-	-	-	-	-
17	Green River	5	X	X	-	-	X	-	-	X	-	-	-	-
18	Buffalo	1	-	-	X	-	X	-	-	-	-	-	-	-
19	Lusk	2	-	-	X	-	X	-	-	B	B	-	-	-
20	Moorcroft	1	X	-	-	-	X	-	-	-	-	-	-	-
21	Bill	1	-	-	-	-	X	-	-	-	-	-	-	-
22	Kemmerer	1	-	-	-	-	X	-	-	X	-	-	-	-
23	Wheatland	1	-	-	-	-	X	-	-	X	-	-	-	-
24	Story	1	X	-	-	-	X	-	-	-	-	-	-	-

* = Bubbler
** = Continuous
† = Ute Research Laboratory Network

APPENDIX C

AIR QUALITY AND METEOROLOGY MONITORING ACTIVITIES BY INDUSTRIAL OIL SHALE DEVELOPERS

-A Summary-

Data Source:

"Summary of Industry Oil Shale Environmental Studies"
by
Rocky Mountain Oil and Gas Association
Oil Shale Committee
March 1975

COMPANY/PERSONNEL

Alantic Richfield Co., Operator
H.M.Dole
Ashland Oil Co.,
C. Hoertz
Shell Oil Co.,
K. Doig
The Oil Shale Corporation
H.M. Spence

AFFILIATION

Colony Development Operation

Ambient Air Quality

Monitoring for sulfur dioxide, total hydrocarbons, oxides of nitrogen and particulates commenced in 1970 in the vicinity of Parachute Creek and subsequently at other locations in valley and plateau locations.

Meteorological Information

Wind speed, wind direction, temperature, relative humidity and precipitation were taken at 8 stations commencing in 1971, in upper Parachute Creek, Parachute Creek corridor and near Grand Valley.

Upper Air and Inversion Studies

Studies of inversions commenced in 1972 in Parachute Creek including tracer releases and meteorological conditions. Continuing.

Atmospheric Diffusion and Tracer Studies

Atmospheric dispersion studies were conducted in 1973 and 1974 for valley and plateau locations including tracer releases and diffusion modeling. Additional studies are continuing.

Trace Element Analyses

Sampling for trace elements in particulates has been conducted periodically in the area of Parachute Creek as part of the Air Quality studies.

Other Information

Studies of mine dust, respirable dust concentrations, sampling equipment evaluation, dust reduction and suppression techniques, settling rates, control of diesel fumes, size and characteristics of mine dust and TLV estimates.

COMPANY PERSONNEL

Alantic Richfield Co., Operator
H.M. Dole
Ashland Oil Co.,
C. Hoertz
Shell Oil Co.,
K. Doig
The Oil Shale Corporation
H.M. Spence

AFFILIATION

Tract C-b — C-b Shale Oil Project

Ambient Air Quality

Per Federal Leasing Requirements

Two-year baseline data acquisition monitored at four station locations, obtaining data 90 of each year.

Monitoring for oxides of sulfur, hydrogen sulfide and suspended particulates at four stations.

Monitoring for oxides of nitrogen, carbon monoxide, ozone, methane and total hydrocarbons at one station.

Additional: A fifth air quality station serves as "back-up" unit and provides additional data.

Contractor: Radian Corporation

Meteorological Information

Per Federal Leasing Requirements

Two-year baseline data acquisition program at four stations (plus one back-up unit) and meteorological tower, obtaining data 95 of each year.

Wind speed, wind direction, temperature, and humidity measured at 30 feet* at the five stations. Precipitation measured at ground level at the five stations. Wind speed, wind direction, and temperature measured at four levels (8, 30, 100 and 200 feet) at 200-foot meteorological tower.

Solar radiation and snow surveys also taken.

Contractor: Radian Corporation

Upper Air and Inversion Studies

Per Federal Leasing Requirements

Upper air studies conducted twice per day, 15 days per quarter to altitudes of 6000 feet above the tract.

Acoustic echo soundings to determine inversion heights.

Contractor: E G G

Atmospheric Diffusion and Tracer Studies

Per Federal Leasing Requirements

Ground level concentration estimates for 24-hour and 3-hour averages are planned.

(Continued)

Atmospheric Diffusion and Tracer Studies (Continued)

Diffusion modeling program will be undertaken to predict effect of estimated plant emissions on ambient air quality in Tract C-b vicinity.

Trace Element Analyses

Per Federal Leasing Requirements
Trace element analysis of suspended particulates once per quarter.
Contractor: Radian Corporation
Volatile trace metal analysis once per quarter.
Contractor: TOSCO Labs.

Other Information

Per Federal Leasing Requirements
Data requirements for C-a, C-b, U-a and U-b:
Map locations of monitoring facilities.

5-minute averages, 4-hour and 24-hour summaries of data available at each trailer.

Tabulation of data summarized in accordance with federal and state ambient air quality standards averaging periods.

Monthly air quality and meteorological reports.

Quarterly data and summary reports to the Mining Supervisor.

COMPANY/PERSONNEL

Standard Oil Co. (Indiana),
R. Schwendinger
Gulf Oil Corporation

AFFILATION

Tract C-a Rio Blanco Oil Shale Project

Ambient Air Quality

Per Federal Leasing Requirements
Similar program as C-b.

Monitoring for oxides of nitrogen, carbon monoxide, ozone, methane, and total hydrocarbons at two stations.
Contractor: E G & G

(Continued)

Meteorological Information

Per Federal Leasing Requirements
Similar programs as C-b.

Three levels (30, 100 and 200 feet) on meteorological tower.
Contractor: E G G

Upper Air and Inversion Studies

Per Federal Leasing Requirements
Similar Program as C-b.
Contractor: E G G

Atmospheric Diffusion and Tracer Studies

Per Federal Leasing Requirements
Similar programs as C-b.

Two tracer releases - one each year.

Trace Element Analyses

Per Federal Leasing Requirements
Similar trace element analysis of suspended particulates as C-b.
Contractor: E G G

Other Information

Per Federal Leasing Requirements
Data requirements for C-a, C-b, U-a and U-b:
Map locations of monitoring facilities.

5-minute averages, 4-hour and 24-hour summaries of data available at each trailer.

Tabulation of data summarized in accordance with federal and state ambient air quality standards averaging periods.

Monthly air quality and meteorological reports.

Quarterly data and summary reports to the Mining Supervisor.

*1 foot is equivalent to 0.3048 meter

COMPANY/PERSONNEL

White River Shale Oil Project,
E. Ramsey
Phillips Petroleum Co.
W.R. Bohon
Sun Oil Co.
R. McClements, Jr.
SOHIO
H. Pforzheimer

AFFILIATION

Tract U-a Tract U-b White River Shale Project

Ambient Air Quality

Per Federal Leasing Requirements
Baseline data measured at 8 locations with one back-up mobile unit.
Contractor: VTN-AeroVironment, Inc.

Meteorological Information

Per Federal Leasing Requirements
Baseline meteorological data measured at 12 locations with one back-up mobile unit.
Meteorological data measured at 3 locations on two 100-foot meteorological towers.
Contractor: VTN-AeroVironment, Inc.

Upper Air and Inversion Studies

Per Federal Leasing Requirements
Similar program as C-b.
Contractor: VTN-AeroVironment, Inc.

Atmospheric Diffusion and Tracer Studies

Perr Federal Leasing Requirements
Similar program as C-b.

Trace Element Analyses

Per Federal Leasing Requirements
Similar trace element analysis of suspended particulates as C-b.
Contractor: VTN-AeroVironment, Inc.

Other Information

Per Federal Leasing Requirements
Data requirements for C-a, C-b, U-a and U-b:
Map locations of monitoring facilities.

(Continued)

Other Information (Continued)

5-minute averages, 4-hour and 24-hour summaries of data available at each trailer.

Tabulation of data summarized in accordance with federal and state ambient air quality standards averaging periods.

Monthly air quality and meteorological reports.

Quarterly data and summary reports to the Mining Supervisor.

COMPANY/PERSONNEL

Union Oil Co.,
J. Hopkins and S. Lipman

Ambient Air Quality

Monitoring for particulates at two stations. Monitoring for sulfur dioxide, oxides of nitrogen, ozone, carbon monoxide, methane, and total hydrocarbons at one station. Began operation November 1974.
Contractor: Sterns-Roger

Meteorological Information

Wind speed, direction, temperature and relative humidity measured at 9 stations. Wind speed, direction and temperature measured at two levels (30, 200 feet) at 200-foot meteorological tower. Precipitation and evaporation measured at 5 stations. Began operation in July 1974.
Contractor: Sterns-Roger

Upper Air and Inversion Studies

Upper air studies conducted six times per day for 8 days, conducted in July and October 1974. Expanding to 15 days for January and April 1975.
Contractor: Colorado International Corp.

Atmospheric Diffusion and Tracer Studies

Will be conducted using data gathered upon completion of baseline studies.

Trace Element Analyses

Program commencing in 1975, to test for trace ambient air contaminants.
Contractor: Union Oil Research

COMPANY/PERSONNEL

Chevron Oil Co.
W.A. Tarleton

Other Information

Consideration being given to studies conducted around Roan Creek Basin/ Joint studies with Getty, Cities Service, Chevron and Texaco to provide information on projected valley versus plateau plant and for Roan Creek Basin April/1975.

COMPANY/PERSONNEL

Getty
D. Nichols

Ambient Air Quality Meteorological Information

Studies being designed as a result of a preliminary feasibility study performed in the spring of 1974 to provide information necessary to design a detailed Meteorology and Air Quality Monitoring Program for its secific site(s).

Upper Air and Inversion Studies Atmospheric Diffusion and Tracer Studies

Studies being designed as a result of a preliminary feasibility study performed in the spring of 1974 to describe in detail the mesoscale circulation patterns and the turbulent diffusion characteristics of the Roan Plateau Drainage Basin.

COMPANY/PERSONNEL

Cities Service
L.C. Holland

Other Information

See Chevron

COMPANY/PERSONNEL

Texaco
I. Hjort

Other Information

See Chevron

COMPANY/PERSONNEL

Superior
B. Weichman

Ambient Air Quality

Monitoring is planned to start this spring for sulfur dioxide, nitrogen dioxide, ozone, total hydrocarbons, methane and particulates. This station will be at the proposed plant site.

Meteorological Information

Proposed monitoring of wind speed, direction, temperature, humidity at 3 sites. Precipitation will be measured at ground level at one site.

Upper Air and Inversion Studies

Upper air studies planned for 15 days per quarter for one year commencing in 1975.

Atmospheric Diffusion and Tracer Studies

Will be modeled at conculsion of baseline data.

Trace Element Analyses

Trace element analysis quarterly from high volume samplers.

COMPANY/PERSONNEL

CER Geonuclear Corp.,

Equity Oil Co.,
P.M. Dougan

AFFILIATION

Project Rio Blanco

Other Information

AEC Plowshare Project Open File and Environmental Impact Statement 1972-1973 contains descriptive material and reports.

COMPANY PERSONNEL

Occidental
R.D. Ridley

Ambient Air Quality

Study underway, completion date February 1976. One high volume sampler at point where stack plume is expected to touch down. Also operating one high volume sampler near existing operation. Since late 1972 performed in-house under direction of consultant.

Meteorological Information

Study underway, completion date February 1976. One station in operation near proposed power plant site. Determines wind direction velocity and temperature 100 feet above the ground. A weather station recording the above plus precipitation has been in operation at the research plant since late 1972. Study conducted in-house and directed by consultant.

Upper Air and Inversion Studies

Upper air and inversion studies are being run in conjunction with the meteorological study. Data are collected only during periods of inversions. Work done in-house under direction of consultants.

Atmospheric Diffusion and Tracer Studies

No in-house studies are currently underway.

Trace Element Analyses

The high volume sampler at the mine workings is aimed at carcinogenic studies.